AN EXPERIMENTAL INVESTIGATION ON USE OF RICE HUSK ASH AND MARBLE DUST AS SMART BUILDING MATERIAL IN BRICK

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Abstract—This paper covered Rice Husk Ash (RHA) and Marble Dust (MD) bricks with variations in its percentage of composition. The paper describes the use of locally available rice husk ash and marble dust in construction industry in a way to minimize the industrial waste. The aim of this paper is to find that percentage of composition by weight of RHA and MD brick which will provide it better strength without any percentage of cement.

The main components are Rice husk Ash (RHA), Marble dust (MD), Sand, Lime (CaCO3), Stone dust and Water which can be utilized to develop low cost energy saving brick. Experiment were performed with different composition of Rice husk Ash and Marble dust. Proportion for main components taken as Rice husk ash and marble dust varying 50-57 %. Other components, sand varying 10-20%, lime varying 7-15%, stone dust varying 10-18%. Engineering properties like compressive strength, water absorption, size and shape evaluated according to Indian Standard Specification and compared to all other possible proportions after curing. Then with the help of graph a comparison between compressive strength of bricks made out of clay, Fly Ash, Rice husk ash and marble dust are determined.

Index Terms—Rice Husk Ash, Marble Dust, natural sand, compressive strength, water absorption, dimension tolerance.

I. INTRODUCTION

Brick is one of the most important construction elements . Burnt clay bricks are most utilizing brick in construction world due to its physical, chemical, mechanical properties. Since the large demand has been placed on building material industry especially in the last decade owing to the increasing population, which causes a chronic shortage of building materials; the civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. The worldwide annual production and the demand for bricks is expected to be continuously rising. An important factor adding to the disadvantages of burnt clay brick is the environmental impact involved in the manufacturing process of clay bricks. To overcome these drawbacks an attempt has been made to increase the overall efficiency of clay brick by other suitable materials in the manufacturing process. Production of building materials, particularly bricks using rice husk ash and marble dust is considered to be one of the solutions to the ever-increasing RHA and MD disposal problem in the country. Although there exist several technologies for producing bricks, the one that is gaining popularity is the automatic brick making machine. The process completely eliminates the thermal treatment and does not require combustion of any fossil fuel.

RHA and MD bricks can be extensively used in all building constructional activities similar to that of common burnt clay bricks. These bricks are comparatively lighter in weight and stronger than common clay bricks. Since RHA and MD are being accumulated as waste material in large quantity near rice mill and marble cutting polishing centre and creating serious environmental pollution problems, its utilization as main raw material in the manufacture of bricks will not only create ample opportunities for its proper and useful disposal but also help in environmental pollution control to a greater extent in the surrounding areas. In view of superior quality and eco-friendly nature, the demand for these bricks can be picked up.

II. SELECTION OF MATERIAL

Rice Husk Ash

Rice is one of the major agricultural crops of India and at least in 75 countries of the world. During milling of paddy about 78 % of weight is received as rice, broken rice and grain . Rest 22 % of the weight of paddy is received as husk . This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash. So for every 1000 kg of paddy milled , about 220 kgs (22 %) of husk is produced , and when this husk is burnt in the boilers , about 55 kg (25 %) of RHA is generated. It is obtained from "Bharat Rice Mill, Tah. Mul, Dist. Chandrapur"

Marble Dust

Marble has been commonly used as a building material since the ancient times. Marble blocks are cut into smaller blocks in order to give the required smooth shape. During the cutting process about 25% the original marble mass is lost in the form of marble sludge. The wet marble sludge was dried up prior to the preparation of the samples. The dried material was sieved through IS sieve no.9 (90 μ) and finally the marble dust was obtained to be used in the experiment. Marble Dust is collected from "Stone Decor Sunrise Marbles, Nagpur"

Lime

It is generally desirable to use a high calcium lime of reasonable purity as it is the most important constituent which reacts with silica and alumina etc. present in the fly ash to form the binder under hydrothermal conditions other burnt lime is not desirable as it does stake readily. The particles of lime should be fine enough to be thoroughly distributed and coat the grains of the mix. It should also satisfy IS: 712-1973. Lime content range from 20 to 30%. (folder IS 01_flyash) Quick Lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% CaO content.

Sand

Deleterious materials, such as clay and silt in sand, shall preferably be less than 5 percent. About 10 to 20% may used. Bottom ash used as replacement of sand shall not have more than 12 percent loss on ignition when tested according to IS 1727 : 1967.

Stone Dust

The crushed stone passing through 10mm sieve was used in research.

Water

Generally potable water was used in this study.

III. RESEARCH METHODOLOGY

The proportion of the raw material is in the ratio 56% of RHA & MD, 12% lime, 16% sand and 16% stone dust. The proportion of raw material may depend upon the quality of raw materials. The materials are mixed in pan mixture. After mixing, the mixture is conveyed through belt conveyor to automatic brick making machine. The homogenous mortar taken out of roller mixer is put into the mould boxes where the brick product is compacted under hydraulic compression.

The bricks are placed on wooden pallets to dried up under sun from 24 to 48 hours, depending on weather. The dried up bricks are stacked and subjected for water spray curing once or twice a day, for 7-10 days, depending on ambience. The bricks are sorted and tested before dispatch.

Table 1 Stipulation for various mixing proportion of brick

Proportion Ratio	50:25:25	00:50:50	00:60:40	00:40:60	00:30:70	00:20:80
FA	28%	0	0	0	0	0
RHA	14%	28%	33.60%	22.40%	16.80%	11.20%
MD	14%	28%	22.40%	33.60%	39.20%	44.80%
STONE DUST	16%	16%	16%	16%	16%	16%
SAND	16%	16%	16%	16%	16%	16%
LIME	12%	12%	12%	12%	12%	12%

IV. TEST RESULT AND DISCUSSION

We have taken some bricks from various mix proportion of rice husk ash and marble dust to conduct few experiments on it and to justify the quality of rice husk ash and marble dust bricks. The experimental observation and result are explained below :

Compressive Strength Test

Table 2 Compressive strength test results

Sr. No	Mix Proportion	Sample	Load KN	Compressive strength N/mm^2	Average Compressive Strength N/mm^2
1	100:00:00	1	160	6.06	4.79
		2	104	3.94	
		3	116	4.39	
2	Red Burnt Clay Brick	1	72	3.2	3.32
		2	78	3.47	
		3	74	3.29	
3	50:25:25	1	96	3.63	3.86
		2	108	4.09	
4	00:50:50	1	64	2.42	2.54
		2	70	2.65	
5	00:60:40	1	84	3.18	3.23
		2	74	3.29	
6	00:40:60	1	128	4.85	4.88
		2	130	4.92	
7	00:30:70	1	160	6.06	6.37
		2	176	6.67	
8	00:20:80	1	160	6.06	5.83
		2	148	5.61	

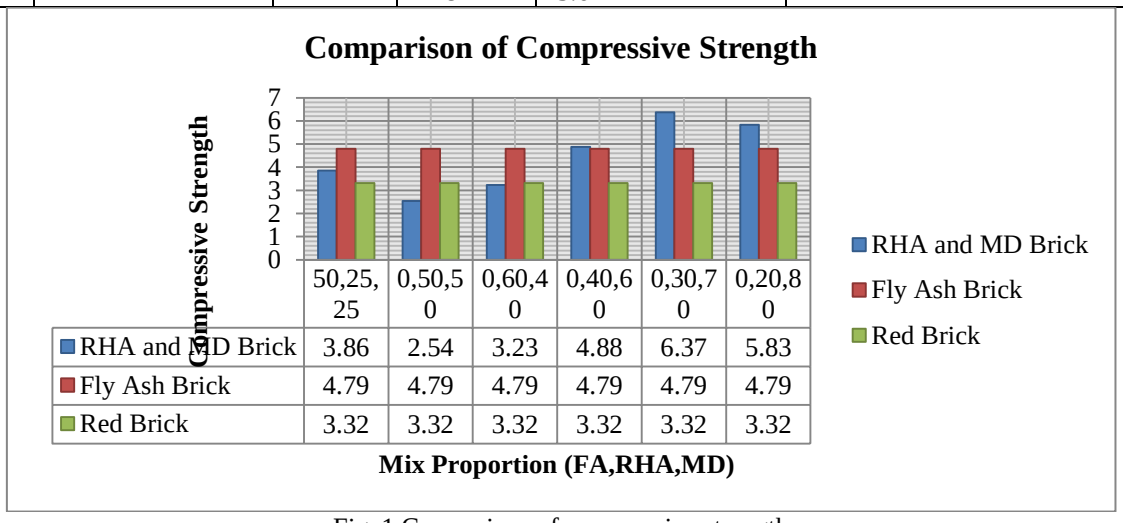

Fig. 1 Comparison of compressive strength

From the above results, the compressive strength of RHA and MD bricks for mix proportion 30% of rice husk ash and 70% marble dust is found to be maximum i.e. 6.37 N/mm^2.

The strength increased by 1.92 times as compare to normal burnt clay brick and 1.33 times as compare to fly ash brick. This strength is more than minimum required compressive strength and belongs to 5 to 7.5 class designation. But for mix proportion 50% of RHA and 50% of MD, compressive strength falls below minimum compressive strength of 3 N/mm^2. After increasing the proportion of RHA & MD in brick the strength is reduced again.

Water Absorption Test

Table 3 Water Absorption Test Results

Sr. No	Mix Proportion	Wt. of dried brick (W_1)	Wt. of water absorbed brick (W_2)	Water Absorption $\frac{W2 - W1}{W1} * 100$
1	Fly ash brick	2470	2820	14.17
2	Red brick	2430	2880	18.51
3	50:25:25	2450	2800	14.29
4	00:50:50	2400	2730	13.75
5	00:60:40	2500	2850	14.00
6	00:40:60	2480	2810	13.31
7	00:30:70	2500	2810	12.40
8	00:20:80	2480	2800	12.90

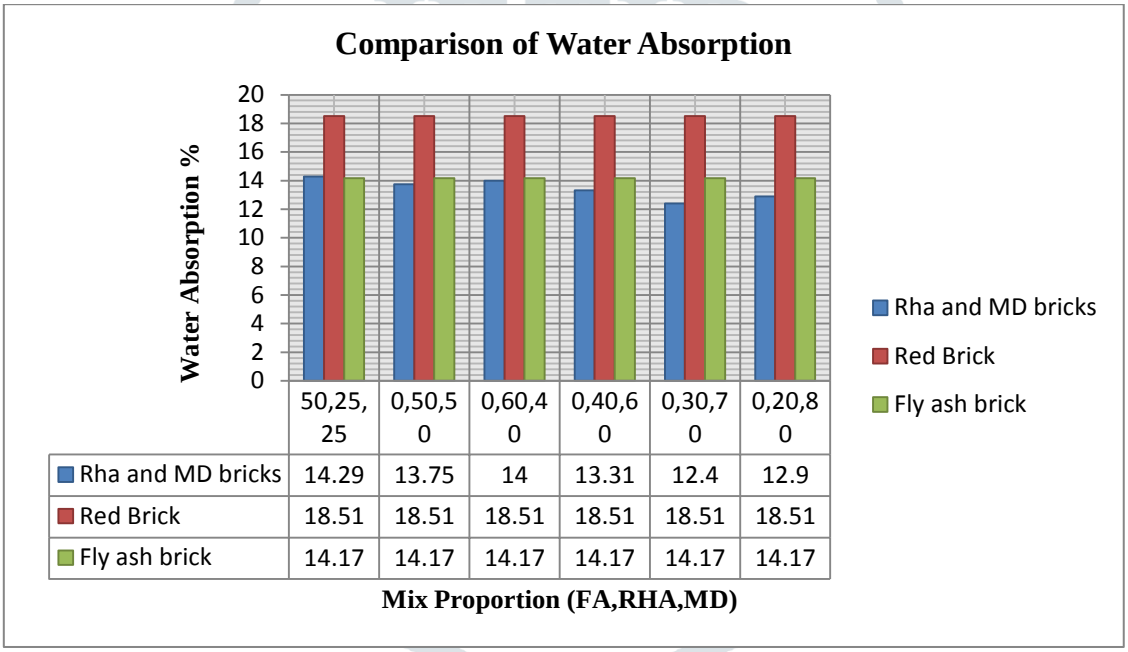

Fig 2 Comparison of Water Absorption

RHA and MD bricks and Fly ash bricks does not have more difference in water absorption. But red burnt clay brick shows higher water absorption than RHA and MD brick. From the results we can conclude that red burnt clay bricks are more porous than rice husk ash and marble dust bricks.

Hardness Test

A good brick should resist scratches against sharp things. So for this test, a scratch is made on brick surface with the help of a finger nail or a sharp tool. If there is no scratch impression is left on the surface of brick then it is said to be hard brick.

Here I found that higher the proportion of MD in bricks have no impression left so the bricks are sufficiently hard but the RHA bricks have some hair cracks.

Test for Structure

To know the structure of brick, I have pick one brick randomly from the group of each proportion and break it. Observe the inner portion of brick clearly. It is found that the broken structure of bricks is homogeneous, compact and free from any defects such as holes, lumps, etc.

Soundness Test

Soundness test of bricks shows the nature of bricks against sudden impact. In this test, the two bricks are taken and they are struck with each other. The bricks should not break and a clear ringing sound should be produced.

It is observed that there is clear ringing sound for higher percentage of marble dust brick and the sound decreases with increase in rice husk ash proportion.

Color Test

A good brick should possess bright and uniform color throughout its body.

Dimension Tolerance Test

Table 4 Dimension Tolerance test result

Arrangement of brick	Dimension specified as IS code (mm)	Actual measured dimension (mm)	Mean measurement for single brick (mm)
Length (L)	4320 to 4680	4660	233
Width (W)	2130 to 2310	2133	106.7
Height (H)	1340 to 1460	1403	70.2

From the measurement done on 20 bricks, the total length, width and height obtained were 4660 mm, 2133 mm and 1403 mm respectively. By taking the mean for the dimensions of a single brick, a brick was 233 mm in length, 106.7 mm in width and 70.2 mm in height. In this case, length width and height of this specimen is found to be within the specified limit. Therefore we can conclude that rice husk ash and marble dust bricks meets the criteria of dimension tolerance.

V. CONCLUSION

1. The rice husk ash and marble dust waste can be utilized in brick and hence solve a potential disposal problem and might be cost effective because this material is available in waste. By use of this aspect we can convert waste into wealth.
2. The compressive strength of RHA and MD bricks for mix proportion 30% of rice husk ash and 70% marble dust is found to be maximum. The strength increased by 1.92 times as compare to red burnt clay brick and 1.33 times as compare to fly ash brick.
3. This strength is more than the minimum required compressive strength and belongs to 5 to 7.5 class designation.
4. Increase in the proportion of marble dust gives compact brick ultimately water absorption will decrease. While the ordinary red burnt clay brick is more porous.
5. As firing of bricks is totally prohibited from the manufacturing process and the bricks industry so it does not evolved CO_2 in the air. The studies were conducted in developing bricks in an eco-environmental method.

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